Grade 3 Science
Achievement Testing Program

Provincial Report

October 1983

Distribution: Officials of Alberta Education

School Principals

Superintendents of Schools

The Alberta Teachers' Association

Alberta School Trustees' Association

General Public upon Request

Alberta
EDUCATION
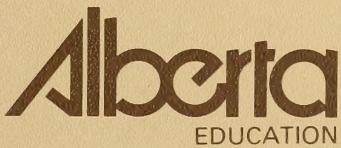
Findings

- The provincial average is 78.2% for knowledge and application of scientific process skills and subject matter.

- Student scores are considerably above the average on the topic of energy, the topic of living things, and the following skills:

    - identifying, through the senses, properties of objects
    - selecting appropriate devices for measuring, and taking measurements
    - classifying objects on the basis of one or two properties
    - constructing charts, pictographs, and bar graphs
    - drawing inferences from direct observation

- Student scores are considerably below the average on the topic of the environment, the topic of properties of objects, the topic of properties of matter, and the following skills:

    - making predictions based on past experience
    - identifying inferences that account for all available observations

Description of the Evaluation

Part A: A 50 question test on scientific process skills and subject matter.

Part B: A 15 question attitude survey on science, conservation, and the environment.

Part C: A teacher questionnaire on availability and use of equipment, student competence in psychomotor skills, and opinion of the test.

Results for Scientific Process Skills and Subject Matter

- The provincial average for the total test is 78.2%

- The provincial averages for the four topics are as follows:

Matter and Energy	– 73.0%
Living Things and the Environment	– 77.0%
Earth-Space and Time	– 75.9%
Scientific Process Skills	– 82.5%

Matter and Energy

- Student scores are considerably above the test average on energy
  (average for two questions is 93.0%).

- Student scores are considerably below the test average on the following:

  - properties of objects (average for five questions is 69.0%)
  - properties of matter (average for four questions is 65.9%)

Living Things and the Environment

- Student scores are considerably above the test average on the classification
  of living things (average for four question is 88.5%).

- Student scores are considerably below the test average on the environment
  (average for two questions is 59.2%).

Earth-Space and Time

- There are no clusters of questions under this topic on which students scored
  considerably above or below the test average.

- The easiest question (#33) requires students to match two events that occur
  in the summer (94.9% of the students answered correctly).

- The most difficult question (#44) requires students to identify, from four
  chemical and physical changes, the one that is most easily reversed
  (58.8% of the students answered correctly).

Scientific Process Skills

Student scores are considerably above the test average on the following skills:

  - identifying, through the senses, properties of objects
    (average for three questions is 94.2%)
  - taking measurements and selecting appropriate devices for measuring
    (average for five questions is 88.6%)
  - classifying objects on the basis of one or two properties
    (average for six questions is 87.7%)
  - constructing charts, pictographs, and bar graphs
    (average for three questions is 88.5%)
  - drawing inferences from direct observation
    (average for four questions is 89.2%)

Student scores are considerably below the test average on the following skills:

- selecting inferences that account for all available observations
  (average for two questions is 64.5%)
- making predictions based on past experience
  (average for five questions is 57.8%)

Results for Attitude Survey

- An average of 53% of the students gave positive responses to the statements about science.

- An average of 65% of the students gave positive responses to the statements about conservation and the environment.

Results for Teacher Questionnaire

- More than 85% of the teachers had access to the following pieces of equipment: metre sticks, thermometers, manipulable materials, balances, and magnets.

- Less than 50% of the teachers had access to the following pieces of equipment: trundle wheels, hand tools, sand boxes, and water tables.

- Teachers gave the highest ratings of student competence for the following skills:

  - measuring length to the nearest metre and centimetre
  - measuring length using non-standard units
  - measuring temperature to the nearest five degrees
  - using scissors to cut out shapes accurately
  - handling, sorting, and placing small objects
  - holding and carrying science equipment correctly and safely
  - describing the position of an object in relation to self

- Teachers gave the lowest ratings of student competence for the following skills:

  - measuring mass to the nearest gram
  - measuring time to the nearest second
  - constructing simple measuring instruments
  - constructing simple science equipment
  - using hand tools safely and correctly

- Approximately 85% of the teachers expressed satisfaction with the quality of the test questions and diagrams.

- Approximately 60% of the teachers indicated that the test questions were consistent with what they were doing in class.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

This report presents the provincial results of the Grade 3 Science Achievement Test administered on June 14, 1983, as part of the Student Achievement Testing Program conducted by Alberta Education.   The results are reported for 23 902 students in public and separate schools.

The report has an executive summary and three chapters.   The Executive Summary contains a brief description of the Grade 3 science program and test, and summarizes the results.   Chapter 1 describes the Achievement Testing Program. Chapter 2 outlines the procedures followed in test development, describes the Grade 3 Science Achievement Test, and defines the sample.   The results are presented in Chapter 3 with guidelines for interpretation.

ACKNOWLEDGMENTS

Chapter 1

THE ACHIEVEMENT TESTING PROGRAM

Purpose

The Achievement Testing Program is designed to provide data on student
achievement in language arts, social studies, mathematics, and science for
Grade 3, 6, and 9. These data are significant at the local and provincial
levels. The purpose of the testing is to monitor the effectiveness of
instructional programs by determining the extent to which curricular
objectives are being achieved. Since averages are reported for a number of
specific topics and skills within each subject area, strengths and weaknesses
across the province and within each jurisdiction can be identified. The
results provide provincial standards and benchmarks that will serve as a basis
for the long-term appraisal of student achievement. These standards will help
jurisdictions to evaluate the effectiveness of their local programs.

1983 Tests

Each test is based on the curriculum as outlined in the *Program of Studies*
for the subject and grade being tested. Only one subject at any grade level
is tested in a given year. The full program of testing is accomplished within
a four-year cycle. In 1983, tests were given in Grade 3 science, Grade 6
mathematics, and Grade 9 social studies.

Tests are administered in June, and the results are reported in the fall. A
summary report is prepared for public distribution, and a more comprehensive
report is issued to jurisdictions. Each jurisdiction receives summary tables
for that jurisdiction and for each school, as well as student scores. Alberta
Education does not issue individual statements of results to students.

Exemptions from Testing

Under normal circumstances, the following classes are exempt from
achievement testing:

- Special Education classes registered for grants with the Special
  Educational Services Branch

- classes in which the language of instruction is other than English,
  under the terms of Section 159 of the *School Act*

- classes in which the subject being tested has been cycled and taught in
  an alternate year

- classes in which the subject has been taught in a semester other than
  that in which the test is being administered

- classes for students for whom English is a second language

Chapter 2

DESCRIPTION OF TEST AND SAMPLE

This chapter outlines the procedures that were followed during test development, describes the test, and describes the student sample that was tested.

Test Development

There were three stages in the development of the Grade 3 Science Achievement Test: preparation of curriculum specifications, development of questions, and selection of questions for the final copy.

1.   Curriculum Specifications

     The Curriculum Branch prepared curriculum specifications based on the *Program of Studies for Elementary Schools*. These specifications assigned weightings to each major content area and to specific topics outlined in the *Program of Studies*. These weightings identified the emphasis that each topic was to receive in the program. The curriculum specifications were distributed to all school jurisdictions in the province, and minor revisions were made on the basis of the feedback that was received. Topic statements from the curriculum specifications upon which specific questions were based are listed under each content area, with the results, in Chapter 3.

2.   Development of Questions

     Committees composed of teachers and Student Evaluation Branch personnel constructed questions to reflect the topic statements listed in the curriculum specifications. After careful review, questions were also selected from existing tests and item banks. The questions were field-tested and revisions were made on the basis of teacher recommendations and the field-test results.

3.   Final Copy

     A test was constructed from those questions that were approved by the teacher committees. Questions were selected from the various content areas so that each area received the emphasis recommended in the curriculum specifications. This version of the test was examined by a Technical Review Committee for content validity, accuracy, and technical merit. Additional changes were made to meet their recommendations.

Test Description

The Grade 3 Science Achievement Testing Program is designed to reflect the following curricular emphases as recommended for science in the *Program of Studies for Elementary Schools*:

> Scientific Process Skills – 55%
> Subject Matter – 20%
> Attitudes – 15%
> Psychomotor Skills – 10%

The Grade 3 testing program has three components. Part A is a 50 question multiple-choice test on scientific process skills and subject matter. Part B is a 15 question attitude survey with opinion statements pertaining to science, conservation, and the environment. Part C is a teacher questionnaire on availability and use of materials and equipment, student competence in handling materials and equipment, and teacher opinion of the test.

Part A – Test on Scientific Process Skills and Subject Matter

The scientific process skills covered by Part A are observing, measuring, classifying, communicating, inferring, and predicting. Part A also covers the subject matter topics of Matter and Energy, Living Things and the Environment, and Earth-Space and Time. The specific topics tested within each content area and sample questions are included, with the results, in Chapter 3. Elective portions of the curriculum are not covered by the test. The test was written in two sections of 25 questions each, and students were allowed 25 minutes to write each section.

The classification of test questions according to content area, specific process skill, and taxonomic level is presented in Table 1.

Table 1

Classification of Test Questions for Part A

	Matter and Energy	Living Things & the Environment	Earth-Space and Time	Process as Content
Number of Questions	10	10	10	20
Test Emphasis	20%	20%	20%	40%

Process Skill	Test Question Numbers			
Observing	1*,26*		2,35*	3,4*,27,28* 29
Measuring		41	6*,43	7,8,9,10* 39*,40,42
Classifying	17,38	14,15,36,37		13,16,34
Communicating			18*	19,20,30,31
Inferring	21,22	49,50	23	48*
Predicting	24,25,45,46	47		
Process Neutral		12*,32*	5,11,33,44	

*Knowledge and comprehension questions

There are 20 questions that independently measure scientific process skills, 24 questions that require an integration of process skills with content from the three subject matter topics, and six questions that do not have a process skill component.

The taxonomic levels used for classification are knowledge and comprehension, and application. Knowledge and comprehension questions require recognition and basic understanding of facts, concepts, and processes. Application questions require students to solve problems and to use concepts and skills in new situations. The test contains 12 knowledge and comprehension questions and 38 application questions.

The taxonomic classification of test questions depends on the manner in which the content has been covered in the classroom. A question that is an application question for one class may be a knowledge question for another class. Teachers should examine this classification to determine whether it is consistent with the way they taught the content.

Part B - Attitude Survey

Students indicate agreement or disagreement with 15 opinion statements
pertaining to science and conservation and the environment. Seven statements
are related to science, seven are related to conservation and the environment,
and one is related to general interest in school learning. The statement on
learning in school was included to provide a comparison with interest in
learning science. The four response alternatives are "I agree," "I am not
sure," "I disagree," "I do not care." Each response alternative is
accompanied by a picture of a face expressive of the response.

Part C - Teacher Questionnaire

Part C is a teacher questionnaire on availability and use of materials and
equipment, and teacher opinion of the test. The questionnaire contains a
checklist on which teachers indicate availability and frequency of use of 15
pieces of equipment and sets of materials. The main body of the questionnaire
requires teachers to estimate the percentage of their students who can perform
laboratory tasks, including 12 measurement tasks, seven tasks involving the
manipulation of small instruments and objects, seven tasks involving assembly
or construction, and four tasks related to spatial relations. The
questionnaire also contains 11 opinion statements pertaining to the quality of
the test and to the appropriateness of the evaluation process.

Population and Sample

A total of 24 739 students were tested (23 902 from 718 public and separate
schools, and 837 students from 75 private schools). The average absentee rate
was 7%. Private school students' results are not included in the results
presented in Chapter 3.

Psychomotor skills questionnaires were sent to each teacher who had a science
class that was tested. Completed questionnaires were returned by 1183
teachers in public and separate schools and by 62 teachers in private schools.

Each school jurisdiction was given the option of either testing all Grade 3
students or testing a sample of students selected by class unit or by school
unit. To ensure a minimal sampling error for jurisdiction results, however,
it was necessary to test almost all of the classes in small jurisdictions.
Since there was little practical benefit from sampling in small jurisdictions,
it was decided to test all classes. Two large jurisdictions opted for
sampling; one chose to sample by class unit and one chose to sample by school
unit.

The sample of classes was obtained by randomly selecting one-third of the
classes in the jurisdiction. The sample of schools was obtained through
stratified sampling procedures to ensure that equal proportions of large and
small schools were included in the sample. The schools in the jurisdiction
were listed from largest to smallest and separated into strata containing six
schools each. Two schools were randomly selected from each stratum, resulting
in a sample consisting of one-third of the schools in the jurisdiction.

The standard error in the provincial mean due to sampling in the two
jurisdictions is negligible, being less than 0.070% for each subtest.

Chapter 3

RESULTS

Results are reported for the 23 902 student test booklets and 1183 teacher questionnaires that were received from public and separate schools. In computing provincial averages and percentages, the results from the two jurisdictions that used sampling were weighted to reflect the proportion of students who were tested in these districts.

Guidelines for Interpretation of Results

Since many factors influence the performance of students within jurisdictions, setting standards is a difficult task. Some of these factors are listed below.

1. The tests were designed to sample the Grade 3 science curriculum, but the amount of instruction given on each topic may vary from one class to another.

2. Any time a test is used to measure achievement, there are minor variations in the results due to factors such as guessing, clerical errors, and errors due to lapses of attention.

3. Since the average level of aptitude is more likely to fluctuate in smaller jurisdictions than in larger ones, small jurisdictions may notice unanticipated levels of achievement in a particular year.

4. Longer subtests are more reliable than shorter subtests in their estimation of average achievement.

5. The tests are necessarily paper-and-pencil representations of the skills developed in science.

6. Elective portions of the curriculum were not covered by the test.

In view of these factors, it was decided that an average of 75% would be a reasonable target for subtest and total test scores. Since the jurisdiction averages are subject to the influences mentioned earlier, target regions have been set up to aid in the interpretation of results. For Total Test and Scientific Process Skills, the regions were set at two percentage points around the target. For the shorter subtests, the regions were set at five points around the target. Jurisdictions with fewer than 100 students writing should use differences of five and ten points to identify areas of strength and weakness. The target regions are given in Table 2.

Table 2

Target Regions

Subtest	Number of Questions	Target Regions (%)	
		<100 Students	>100 Students
Total Test	50	70 – 80	73 – 77
Scientific Process Skills	20	70 – 80	73 – 77
Matter and Energy	10	65 – 85	70 – 80
Living Things and the Environment	10	65 – 85	70 – 80
Earth-Space and Time	10	65 – 85	70 – 80

To interpret results for a jurisdiction, the reader should first read the
sample questions, examine the test specifications, and decide whether the
target levels are appropriate for that jurisdiction. Next, the jurisdiction
averages should be compared with the target values and those averages outside
the target regions noted.

It must be emphasized that the purpose of the Achievement Testing Program is
to produce results valid at the jurisdictional and provincial levels, not at
the individual class or student level. Because of restrictions of time and
space, the test questions are only a small sample of possible questions for
any curricular objective. Thus, individual student scores on short subtests
may vary greatly, depending on the specific questions selected. Caution must
be exercised when comparing averages for single class units because of the
large variation in student ability from one class to another.

For large groups of students, variations due to question selection will
average out. If the group size is sufficiently large, it is meaningful to
compare the achievement of groups of students with the provincial averages.
Again, the two- and five-point guidelines are useful for the larger
jurisdictions, and the five- and ten-point guidelines can be used by
jurisdictions with fewer than 100 students. Jurisdictions with fewer than 25
students should exercise caution when comparing results with provincial
averages. Jurisdictional results are presented in tables that parallel the
tables of provincial results to facilitate comparisons.

When examining the results of the achievement tests, readers should keep in
mind that a test score cannot reveal why a performance occurred, only that it
did occur. After areas of strength and weakness have been determined, the
difficult task of identifying the reasons for these strengths and weaknesses
should be undertaken. A variety of factors should be examined.

1.   Student motivation. Were students motivated to take the test?

2.   Student ability. A group of students with a particularly high or low
      ability level may have been tested. This is much more likely to occur in
      small systems than in large ones.

3.   Teaching curriculum. Since much care was taken in designing the test to
      fit the Alberta curriculum, areas of weakness may be the result of
      discrepancies between provincial and local programs.

There will, of course, be other factors that are of importance in particular
jurisdictions. Jurisdictions are encouraged to establish local interpretation
panels to examine the results in light of local factors.

Absentee Rates

If more than 10% of the eligible students in a jurisdiction did not write the
test, the reported averages for that jurisdiction may not accurately represent
the true averages. Teacher-assigned marks for students who did not write
could be compared with teacher-assigned marks for students who did write. If
the averages are the same for the two groups, the reported achievement
averages are probably representative. If the averages are different, some
estimates can be made of what the achievement averages might have been if all
students had written the test. Jurisdictions with high absentee rates may
wish to contact the Student Evaluation Branch for assistance in estimating
their averages.

Cautions

The following cautions should be observed when examining the results for the
Grade 3 Science Achievement Test.

1.   The findings are limited to those that can be obtained from a
      pencil-and-paper test; many skills developed in science cannot be
      measured by this type of test.

2.   The questions on the test cover a representative sample of the objectives
      for Grade 3 Science in the *Program of Studies for Elementary Schools*.

3.   Although areas of high and low achievement are identified in the report,
      no attempt is made to interpret the differences. Possible explanations
      include the following:

      - questions on a given topic may be exceptionally difficult or easy
      - a given topic may have been taught poorly or taught exceptionally well
      - a set of objectives may be too difficult for Grade 3 students to attain
        or may be trivial for Grade 3 students.

Part A - Test on Scientific Process Skills and Subject Matter

Over 99% of the students completed the test, indicating that sufficient time was allowed. The KR-20 coefficient for the test is 0.80. The standard error of measurement is 5.0%.

Subtests for Part A of the test are made up of questions which have been grouped according to content area, specific process skill, and cognitive level. Provincial averages in per cent are reported in Table 3 for 12 subtests and the total test. The number of questions in each subtest is also given. The four main content areas are Scientific Process Skills, Matter and Energy, Living Things and the Environment, and Earth-Space and Time. Averages are reported for the following process skills: observing, measuring, classifying, communicating, inferring, and predicting. Averages are also reported for knowledge and comprehension questions and for application questions. The specific question numbers for each subtest are identified in Table 1 in Chapter 2.

Table 3

Provincial Averages for Subtests in Part A

Subtest	Number of Questions	Average (%)
Matter and Energy	10	73.0
Living Things and the Environment	10	77.0
Earth-Space and Time	10	75.9
Scientific Process Skills	20	82.5
Observing	9	80.3
Measuring	10	77.7
Classifying	9	82.3
Communicating	5	83.0
Inferring	6	80.7
Predicting	5	57.5
Knowledge and Comprehension	12	90.0
Application	38	74.5
Total Test	50	78.2

The standard deviation for the total test is 11.5%.

The averages for the total test and for Scientific Process Skills are above the upper limits of the target regions identified in Table 2 on page 7. The averages for Matter and Energy, Living Things and the Environment, and Earth-Space and Time are within the target regions.

The average is 80.9% for the six questions that do not have a process skill component, whereas the average is 73.9% for the 24 questions that require students to integrate process skills with the three subject matter topics. The average for the knowledge and comprehension questions (90.0%) is considerably higher than the average for the application questions (74.5%). This difference is consistent across the four content areas. The average for Predicting is considerable lower than the averages for the other subjects.

The results for each content area are discussed in detail in the following sections. The topics that were tested within each content area are listed and sample questions from the test are provided. The darkened circle in each question identifies the correct response, and the percentage of students selecting each response is given. Areas of high and low achievement are identified.

Matter and Energy

Questions in this content area are related to properties of objects, properties of matter, and energy. The specific topic statements covered by the test are the following:

- objects exhibit a number of properties
- properties of objects can be determined through the use of the senses
- objects can be compared, ordered, and classified according to one or more property
- matter can undergo changes due to heating or cooling
- some solid materials float in water, some do not
- there are different forms of energy
- humans can exhibit behaviors that conserve energy in their environment

The following example requires students to make a prediction based on their knowledge of floating objects.

Question 46: Ice cubes are made by freezing water. An ice cube is placed in a glass of cold water. How far will it sink?

				no response
○	●	○	○	
Student responses: 4.9%	63.3%	4.5%	25.9%	1.4%
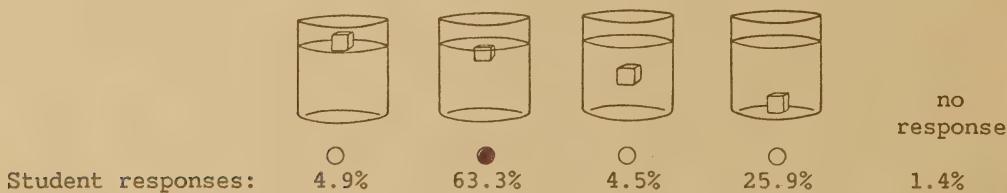
The average for the ten questions on Matter and Energy is 73.0%. Student scores are considerably above the test average on energy (average for two questions is 93.0%). Student scores are considerably below the test average on the following topics:

- properties of objects (average for five questions is 69.0%)
- properties of matter (average for four questions is 65.9%)

Living Things and the Environment

Questions in this content area are related to living things, plants and animals, and the environment. The specific topic statements covered by the test are the following:

- things can be classified as living or non-living
- living things can be classified according to properties
- plants and animals live in many different habitats
- some young animals resemble their parents while others do not
- it is important to protect and maintain the environment
- the environment plays an important role in our lives

The following example requires knowledge of the larva stage of the butterfly.

Question 32: Look at this picture.
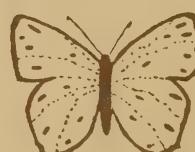
What did this animal look like when it was young?

				no response
○	○	○	●	
Student responses: 0.7%	2.4%	1.0%	94.8%	1.1%
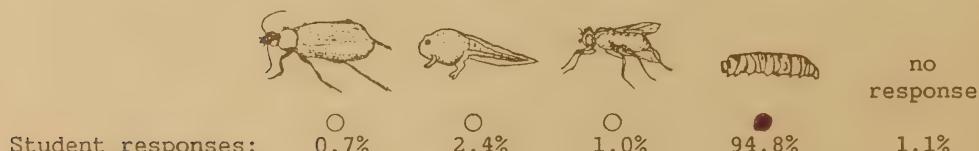
The average for the 10 questions on Living Things and the Environment is 77.0%. Student scores are considerably above the test average on the classification of living things (average for four questions is 88.5%). Student scores are considerably below the test average on the environment (average for two questions is 59.2%).

Earth-Space and Time

Questions in this content area are related to position and direction, and order and time. The specific topic statements covered by the test are the following:

- an object's position can be determined by using a simple grid
- an object's position, size, and direction can be described
- distance can be measured using standard and non-standard units
- the position of an object is determined relative to arbitrarily chosen reference points
- some changes occur in a regular pattern and can be ordered
- some changes are reversible and others are not
- changes in the weather are preceded by observable signs

The following example requires students to apply the concepts of reversible and irreversible changes.

Question 44: The groups of pictures below show different kinds of changes.

paper burning

nail rusting

ice cube melting

log rotting
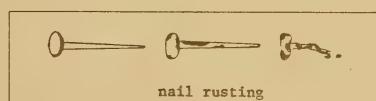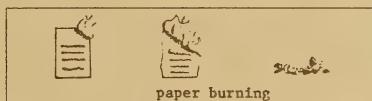
Student responses

Which change would be easiest to change BACK?

58.8% ● melting
8.4% ○ burning
21.4% ○ rusting
10.4% ○ rotting
1.0% no response

The average for the 10 questions on Earth–Space and Time is 75.9%. There are no clusters of questions under this content area for which students scored considerably above or below the test average. Students found Question 33 to be the easiest. It requires students to match two events that occur in the summer (94.9% of the students answered correctly). The students found Question 44 to be the most difficult. This question is presented on page 12 as the example (58.8% of the students answered correctly).

Scientific Process Skills

The process skills covered by the test are listed below:

observing   – identifying, through the senses, properties of objects
                – distinguishing between observations and inferences
                – describing changes in and interactions among objects
                – selecting appropriate devices for measurement

measuring   – using simple instruments for measurement
                – collecting data using appropriate measuring devices
                – estimating the approximate measure of an object
                – ordering objects on the basis of measurement

classifying   – identifying the basis of a given classification set
                – classifying objects on the basis of one, two, and three
                  properties

communicating – describing the observable properties of objects
                – constructing charts, pictographs, and bar graphs
                – drawing simple diagrams
                – recording responses by using symbols

inferring   – identifying inferences that account for all available
                  observations
                – drawing inferences from direct observation

predicting   – making predictions based on past experience

The following example on Observing requires students to distinguish between observations and inferences.

   Question 27: What is happening in the picture?

   Student responses

       80.9%● John is blowing up the balloon.
        2.2%○ The balloon will burst.
        0.6%○ John is having a birthday party.
       15.7%○ The balloon will get bigger.
        0.6%   no response

The following example on Measuring requires students to read a thermometer to the nearest degree.

Question 10: Which thermometer shows 36°C?

				no response
○	○	●	○	
Student responses: 2.8%	6.3%	88.7%	1.9%	0.1%

The following example on Classifying requires students to identify the basis of a classification set and then classify an object on the basis of two properties.

Question 16: Look at the pictures of make-believe pond-water creatures.

These are zonks.   NONE of these is a zonk.

Which of these is a zonk?

				no response
○	○	●	○	
Student responses: 4.1%	5.2%	83.4%	5.5%	1.8%

- 14 -

The following example on Communicating requires students to read data presented in a chart.

Question 19: The chart shows what four students do after school.

ACTIVITY

NAME	Piano Lessons	Brownies	Cubs	Swimming
Bob	X		X	
Joan	X			X
Beth		X		X
Jim	X		X	X

What does this chart tell you?

Student responses

     10.9%○ Bob and Jim both take piano lessons, belong to Cubs,
              and go swimming.
      2.9%○ Beth does not go swimming.
      2.0%○ Joan and Beth both belong to Brownies.
     83.1%● Bob, Joan, and Jim all take piano lessons.
      1.1%   no response

The following example on Inferring requires students to draw an inference from an observation of weather conditions.

Question 23: It is summertime. Which clouds would you expect to see
              during a thunderstorm?

				no
○	○	●	○	response
8.4%	6.5%	76.7%	6.7%	1.7%

Student responses:

The following example on Predicting requires students to make a prediction based on their knowledge of the rate of decay of garbage left in the environment.

Question 47:   At the end of a picnic, the garbage was buried in the ground. Several years later it was dug up. The garbage that is most likely to stay the same is

35.1% ● ⬚ a plastic cup   27.9% ○ ◑ an orange peel

22.6% ○ ⬭ a paper plate   12.1% ○ ◖ an egg shell

2.3% no response
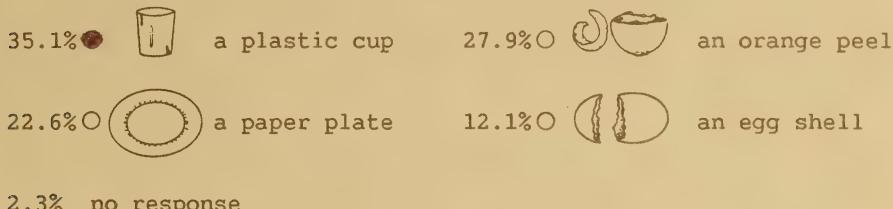
The average is 82.5% for the 20 questions that measure Scientific Process Skills independent of the three subject matter topics. The average is 73.9% for the 24 questions that measure student ability to integrate process skills with content from the three subject matter topics. The averages for the six process skills are as follows:

        observing – 80.3%   communicating – 83.0%
        measuring – 77.7%   inferring – 80.7%
      classifying – 82.3%   predicting – 57.5%

The questions that require integration of process skill with subject matter content have been included in the computation of the above averages and in the following identification of areas of high and low achievement.

Student scores are considerably above the test average on the following skills:

    - identifying, through the senses, properties of objects
      (average for three questions is 94%)
    - selecting appropriate devices for measuring and taking measurements
      (average for five questions is 89%)
    - classifying objects on the basis of one or two properties
      (average for six questions is 89%)
    - constructing charts, pictographs, and bar graphs
      (average for three questions is 89%)
    - drawing inferences from direct observation
      (average for four questions is 89%)

Student scores are considerably below the test average on the following skills:

    - selecting inferences that account for all available observations
      (average for two questions is 65%)
    - making predictions based on past experience
      (average for five questions is 58%)

Results for Individual Questions

The percentage of students choosing each response for each question is given in Table 4. The correct response for each question is also identified.

Table 4

Results for Individual Questions

Question Number	Correct Response	Distribution of Responses in %*				Question Number	Correct Response	Distribution of Responses in %*			
		A	B	C	D			A	B	C	D
1	B	6.1	90.6	2.2	0.4	26	C	2.1	0.4	96.8	0.2
2	C	15.8	18.4	60.5	4.9	27	A	80.9	2.2	0.6	15.7
3	A	35.3	30.3	28.4	5.6	28	B	1.3	95.3	1.6	1.3
4	B	3.8	90.5	1.2	4.1	29	B	12.5	82.1	2.3	2.2
5	D	23.6	8.1	2.4	65.2	30	B	0.8	91.4	0.6	1.1
6	B	0.8	94.0	0.4	3.2	31	C	2.3	4.4	89.1	3.2
7	B	0.6	96.9	1.8	0.2	32	D	0.7	2.4	1.0	94.8
8	D	4.7	1.8	14.7	78.1	33	D	0.8	0.9	2.6	94.9
9	A	72.9	2.5	3.4	18.3	34	A	57.7	6.9	9.2	24.4
10	C	2.8	6.3	88.7	1.9	35	B	6.5	88.9	2.2	1.8
11	A	88.8	1.9	4.4	4.2	36	C	5.3	9.2	74.1	10.2
12	B	2.6	87.0	1.9	7.5	37	B	3.1	92.9	1.1	2.1
13	C	1.1	0.7	96.7	0.7	38	C	0.6	1.2	51.9	45.4
14	D	1.5	1.5	2.5	92.9	39	B	1.0	95.5	1.3	1.5
15	B	1.9	94.0	2.1	1.2	40	D	1.7	3.7	7.6	85.9
16	C	4.1	5.2	83.4	5.5	41	C	0.1	1.5	24.8	72.8
17	A	96.3	0.9	1.1	1.2	42	C	0.4	8.1	75.3	15.4
18	C	19.8	8.7	68.1	1.8	43	D	15.8	2.6	12.5	68.0
19	D	10.9	2.9	2.0	83.1	44	A	58.8	8.4	21.4	10.4
20	B	3.4	85.1	2.1	2.0	45	C	4.1	9.7	53.5	31.6
21	A	52.2	15.6	16.6	14.5	46	B	4.9	63.3	4.5	25.9
22	D	2.1	1.0	2.4	89.6	47	A	35.1	27.9	22.6	12.1
23	C	8.4	6.5	76.7	6.7	48	B	4.0	91.7	2.4	1.0
24	A	93.5	3.0	1.2	0.7	49	D	1.7	2.9	2.3	92.0
25	B	14.4	43.5	20.0	19.9	50	C	9.3	2.7	83.3	3.9

*The sum of the percentages for each question is less than 100% because the no response category is not included. This is less than 2% except for Questions 9, 20, 22, 25, 30, and 47. For questions in which the alternatives are arranged in two rows of two, the top two are A and B, and the bottom two are C and D.

Comparison with the 1978 MACOSA Results

No comparison is possible since there has been a substantial change in emphasis in the elementary science program since 1978.

Comparison with the 1982 Grade 6 Results

Five questions from the 1982 Grade 6 Science Achievement Test are on the Grade 3 test. All five questions measure Scientific Process Skills; there are two on observing and one on each of measuring, classifying, and predicting. The question numbers on the Grade 3 test are 3, 10, 13, 29, and 47. The averages for these questions are as follows:

Grade 3	Grade 6
67.6%	74.7%

Part B - Attitude Survey

The percentage of students selecting each response for each statement in Part B is given in Table 5.

Table 5

Student Responses to Part B

	Statement	Percentage of Students				
		A	NS	D	DC	NR*
1.	I like learning in school.	77.1	10.4	7.3	4.9	0.3
2.	I like learning about science.	55.6	24.2	10.0	9.8	0.3
3.	Science ideas are interesting.	69.1	19.8	5.6	5.2	0.3
4.	Science is very important.	71.5	19.0	4.5	4.7	0.3
5.	Science is too difficult for most people to understand.	21.7	41.0	31.9	5.1	0.4
6.	Doing science gives me a chance to think like a scientist.	55.6	23.0	13.7	7.4	0.3
7.	I like to watch science programs on television.	46.5	14.4	25.1	13.5	0.4
8.	I like to read science magazines.	41.0	22.0	23.8	12.8	0.4
9.	I would like to learn more about the environment.	60.5	21.7	7.3	9.9	0.5
10.	I think about what my environment will be like when I grow up.	50.8	33.9	7.3	7.6	0.4
11.	We should use less energy so that there will be more to share with others.	71.7	14.7	7.5	5.7	0.4
12.	Saving paper, bottles, and cans is worth the time and effort it takes.	60.3	20.8	10.3	8.2	0.3
13.	I always put candy wrappers in the garbage.	63.5	21.4	11.2	3.4	0.5
14.	Since there are many kinds of animals and plants, we should not worry if a few kinds die out forever.	17.4	16.3	60.6	5.1	0.6
15.	I like to spend time outdoors.	86.3	5.3	2.8	5.3	0.3

* A - I agree   D - I disagree   NR - no response
  NS - I am not sure   DC - I do not care

In the discussion of the responses to the attitude survey, the following definitions are used:

positive response – agreement with a positive statement or disagreement with a negative statement

negative response – agreement with a negative statement or disagreement with a positive statement

Statements 5 and 14 are the only negative statements. The statement receiving the most positive response is Statement 15 with 86.3% of the students agreeing that they like to spend time outdoors. The statement receiving the least positive response is Statement 5 with 31.9% of the students disagreeing that science is too difficult for most people to understand. The percentage of students selecting "not sure" ranged from 5.3% for Statement 15 to 33.9% for Statement 10. The percentage of students selecting "do not care" ranged from 3.4% for Statement 13 to 13.5% for Statement 7.

Statement 1 was included for comparison with Statement 2. While 77.1% of the students agree that they like learning in school, only 55.6% agree that they like learning about science.

Statements 2 through 8 are related to science in general, and Statements 9 through 15 are related to conservation and the environment. The responses for these two clusters of statements are summarized in Table 6. The numbers presented in the table are the averages for the seven statements in each cluster.

Table 6

Summary of Responses to Part B

Topic	Average Percentage of Students			
	Positive	Negative	Not Sure	Do Not Care
Science	53.0	23.3	14.9	8.4
Conservation and Environment	64.8	19.2	9.1	6.5

Part C – Teacher Questionnaire

The detailed results for the teacher questionnaire are reported in the Appendix. The responses to the section on availability and use of equipment and materials are summarized in Table 7, which contains the percentages of teachers who had access to the equipment and the percentages of teachers who used the equipment at least once. The pieces of equipment and materials are listed in order from most used to least used.

Table 7

Availability and Use of Equipment and Materials

Equipment and Materials	Percentages of Teachers	
	Availability	Use
metre sticks	98.3	95.7
thermometers	94.1	88.8
manipulable materials	92.9	87.0
balances	87.5	79.7
magnets	86.8	70.6
timepieces	74.2	70.3
hand lenses	79.6	68.4
planting materials	80.0	67.1
graduated cylinders	74.8	61.1
eyedroppers	74.6	56.1
blocks	59.5	51.5
trundle wheels	46.8	37.4
hand tools	36.1	25.5
sandboxes	21.9	15.6
water tables	9.9	7.3

The percentages of teachers who used materials more than once were also
examined. Over 80% of the teachers used metre sticks, thermometers, and
manipulable materials more than once. Between 40% and 60% of the teachers who
had access to the following materials did not use them more than once:
magnets, planting materials, eyedroppers, graduated cylinders, trundle wheels,
hand tools, sandboxes, and water tables.

The responses to the sections on psychomotor skills and spatial relations are
presented in Figures 2 to 4. For each task, the graphs show the percentage of
teachers indicating that at least 75% of their students could perform the
task. The results for the measurement psychomotor skills are presented in
Figure 2. Figure 3 presents the results for skills that involve manipulating,
assembling, and constructing materials and equipment. The results for skills
that involve spatial relations are presented in Figure 4.

Figure 1

Teacher Ratings for Measurement Psychomotor Skills
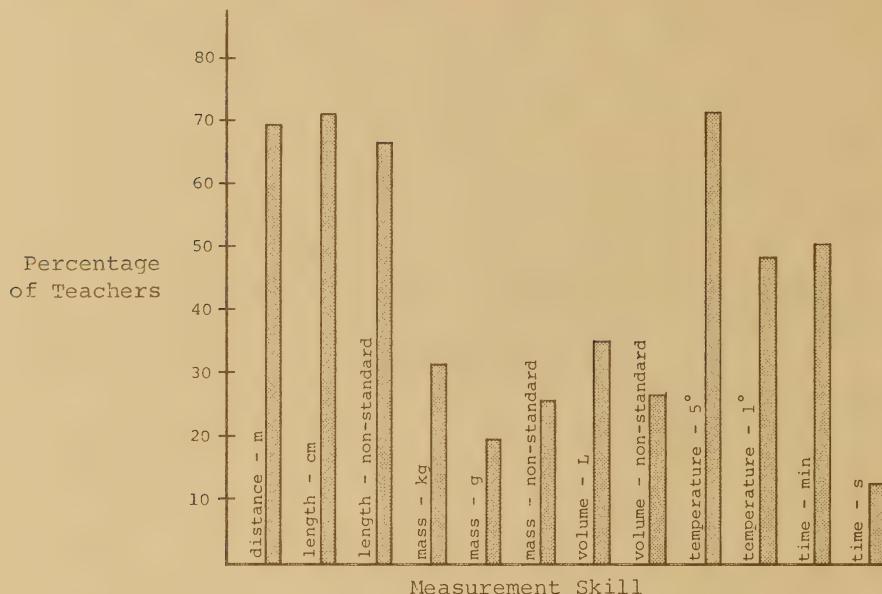
Figure 2

Teacher Ratings for Skills that Involve
Manipulating, Assembling, and Constructing Equipment
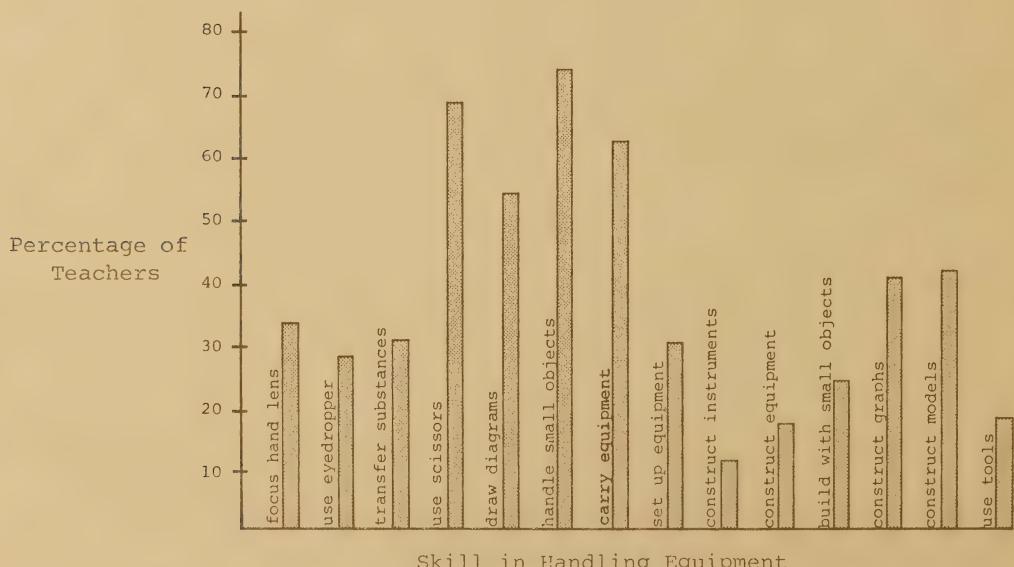
Figure 3

Teacher Ratings for Spatial Relations


Percentage of
Teachers

Spatial Relations

Teachers gave the highest ratings of student competence for the following skills:

- measuring length to the nearest metre and centimetre
- measuring length using non-standard units
- measuring temperature to the nearest five degrees
- using scissors to cut out shapes accurately
- handling, sorting, and placing small objects
- holding and carrying science equipment correctly and safely
- describing the position of an object in relation to self

Teachers gave the lowest ratings of student competence for the following skills:

- measuring mass to the nearest gram
- measuring time to the nearest second
- constructing simple measuring instruments
- constructing simple science equipment
- using hand tools correctly and safely

Teacher responses concerning the test, attitude survey, and teacher questionnaire are generally positive. The percentage of teachers agreeing with each statement are given in Table 8. These percentages are the sums for the "agree" and "strongly agree" alternatives. The statements have been converted to phrases for presentation in the table.

Table 8

Teacher Opinions

Statement	Percentage of Teachers Indicating Agreement
a. sufficient time for test	93.6
b. high quality test items	78.2
c. appropriate diagrams	92.5
d. high quality diagrams	86.3
e. test reflects *Program of Studies*	70.4
f. test reflects teaching emphasis	60.5
g. test did not cover all material taught	58.7
h. items similar to items used in class	55.8
i. attitude survey reflects attitudes taught in science	69.9
j. questionnaire reflects skills needed in science	78.6
k. have all resources required to teach program	51.8

Statements b, c, and d relate to the quality of the test questions and diagrams. An average of 85.7% of the teachers gave positive responses to these statements. Statements e, f, and h relate to how well the test reflects the *Program of Studies* and classroom practice. An average of 62.2% of the teachers gave positive responses to these statements.

Approximately 20% of the returned questionnaires contained additional comments, most of which were positive. Teachers said that the reading level and content of the test were appropriate, that the test was fair, and that the test reflected the *Program of Studies*. Many teachers also said that they felt that the test was a positive way to introduce testing to Grade 3 students: students appeared to enjoy writing the test and did not appear to be frustrated or anxious. Approximately 4% of the teachers indicated that the reading level in the test was too high or that the content was inappropriate. Approximately 3% of the teachers said that the questionnaire would be useful for planning science activities.

Concluding Observations

The provincial average for the total test is slightly above the target region identified under the guidelines for the interpretation of results. The provincial average for Scientific Process Skills is considerably above the target region. The provincial averages for the three subject-matter content areas are within the target regions.

The responses to the attitude survey are generally positive. The results of the teacher questionnaire indicate that most teachers have used basic equipment and that a majority of the students can demonstrate a variety of skills in the laboratory. Teacher responses concerning the test are generally positive.

TEACHER QUESTIONNAIRE RESPONSES

The detailed results for the teacher questionnaire are reported in this appendix. The percentage of teachers selecting each response is given in the following tables.

Question 1:

Number of students in your Grade 3 science class(es) Avg. = 20.7; NR = 15.8%

Responses to Question 2 are presented in Table 9.

Table 9

Teacher Responses for Availability and Use of Equipment

		Available			Use by Students			
		YES	NO	NR*	1 time	2-9 times	10 or more times	NR*
a.	Metre sticks	98.3	0.9	0.8	1.5	49.9	44.3	2.3
b.	Trundle wheels	46.8	44.4	8.8	18.0	17.6	1.8	62.6
c.	Graduated cylinders	74.8	20.7	4.5	18.5	38.7	3.9	38.9
d.	Thermometers	94.1	4.7	1.2	8.1	63.6	17.1	11.2
e.	Hand lenses	79.6	16.8	3.6	17.9	41.1	9.4	31.6
f.	Eyedroppers	74.6	21.1	4.3	25.6	26.3	4.2	43.9
g.	Magnets	86.8	10.0	3.2	21.4	40.5	8.7	29.4
h.	Blocks	59.5	30.9	9.6	9.8	27.0	14.7	48.5
i.	Balances	87.5	10.7	1.8	16.7	50.0	13.0	20.3
j.	Manipulable materials	92.9	4.6	2.5	5.3	45.4	36.3	13.0
k.	Sandbox	21.9	71.2	6.9	4.4	5.0	6.2	84.4
l.	Water table	9.9	81.2	8.9	3.1	3.5	0.7	92.7
m.	Planting materials	80.0	17.0	3.0	23.1	38.8	5.2	32.9
n.	Hand tools	36.1	57.9	6.0	9.5	13.5	2.5	74.5
o.	Timepieces	74.2	22.4	3.4	7.7	37.4	25.2	29.7

* NR denotes no response.

Responses to Questions 3-5 are presented in Table 10. Teachers were asked to indicate the percentage of their students who could perform each task. The percentage of teachers selecting each response is given.

Table 10

Teacher Responses for Psychomotor Skills and Spatial Relations

Task	\	Response Category				
	0%	1%–25%	26%–50%	51%–75%	76%–100%	N/A
measure:						
distance – m	0.2	2.1	5.9	20.1	69.6	1.4
length – cm	0.1	1.9	4.0	21.6	70.9	0.6
length – non-standard	0.2	2.2	5.6	23.4	66.0	1.9
mass – kg	1.6	7.1	13.6	34.0	31.7	11.3
mass – g	2.8	13.2	16.0	33.0	19.0	14.8
mass – non-standard	1.8	7.4	13.5	32.5	25.2	18.6
volume – L	1.0	6.9	12.5	31.6	34.1	12.9
volume – non-standard	1.1	5.2	12.1	30.9	26.4	23.2
temperature – 5°	0.1	1.5	3.1	17.9	71.7	4.9
temperature – 1°	0.7	3.8	9.8	31.6	48.2	5.1
time – min	0.0	2.4	8.8	32.9	50.5	4.5
time – s	2.7	12.0	18.0	22.8	12.0	31.8
focus hand lens	0.7	4.2	5.7	18.5	34.6	34.9
use eyedropper	0.5	2.5	5.5	21.5	28.9	39.7
tranfer substances into a narrow						
container	0.7	3.4	11.3	36.0	30.9	16.9
use scissors	0.2	1.1	3.9	24.0	69.0	0.9
draw diagrams	0.4	1.4	7.1	35.0	54.4	0.7
handle small objects	0.1	1.0	2.7	15.4	73.9	6.1
carry equipment	0.2	1.3	3.9	26.2	63.6	4.0
set up equipment	0.5	2.7	12.1	44.2	30.9	9.0
construct instruments	1.2	5.9	14.5	23.9	12.5	41.2
construct equipment	0.6	3.9	13.9	25.4	18.5	36.9
build with small objects	0.7	3.7	10.8	28.1	25.6	30.4
construct charts						
and graphs	0.7	3.5	10.1	35.3	41.2	8.4
construct models	0.5	3.2	10.7	28.2	42.4	14.3
use hand tools	0.3	2.8	9.3	23.0	19.5	44.5
describe position – self	0.0	1.5	3.5	14.5	78.5	1.5
describe position – other						
objects	0.3	3.4	10.9	39.4	37.6	7.8
place objects	0.0	1.8	6.8	29.6	58.8	2.5
move to predetermined						
position	0.2	3.2	11.7	36.1	29.4	18.8

*N/A – no opportunity to observe task. Percentages for a given task do not add to 100% because the "no response" category has been omitted. This is less than 1.5% for all tasks.

Table 11

Percentage of Teachers Selecting Each Response to the
Opinion Statements

Statement	SA	A	U	D	SD	NR*
Sufficient time was allowed for the Grade 3 Science Achievement Test.	51.6	42.0	0.7	1.1	0.5	4.1
The items on the test were of high quality.	16.8	61.4	14.3	4.1	0.1	3.3
The diagrams in the test were appropriate.	25.9	66.6	2.4	2.0	0.1	3.0
The diagrams in the test were of high quality.	26.0	60.3	6.8	3.0	0.5	3.4
The test reflects the *Program of Studies*.	9.7	60.7	17.8	7.5	0.8	3.5
The test reflects my teaching emphasis.	5.1	55.4	23.0	11.6	0.9	4.0
The test did not cover all the material that was taught.	7.0	51.7	19.8	17.1	0.7	3.7
The test items are similar to items I have used with my students.	3.7	52.1	11.8	27.2	1.8	3.4
The Attitude Survey reflects attitudes taught in science.	9.4	60.5	18.8	4.7	1.6	5.0
The Science Psychomotor Skills Questionnnaire reflects the development of skills needed in science.	10.0	68.6	15.8	1.7	0.3	3.6
All the resources required to teach the Science Program were available.	6.7	45.1	9.7	29.3	5.9	3.3

* SA – Strongly Agree   U – Undecided   SD – Strongly Disagree
  A – Agree   D – Disagree   NR – No Response